

**BLACKSTONE RIVER BASIN
WORCESTER, MASSACHUSETTS**

**WILLIAMS MILL POND DAM
MA 00121**

PHASE I INSPECTION REPORT NATIONAL DAM INSPECTION PROGRAM

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**DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154**

APRIL 1979

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER MA 00121	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Williams Mill Pond Dam		5. TYPE OF REPORT & PERIOD COVERED INSPECTION REPORT
6. AUTHOR(s) NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS		7. PERFORMING ORG. REPORT NUMBER
8. AUTHOR(s) U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION		9. CONTRACT OR GRANT NUMBER(s)
10. PERFORMING ORGANIZATION NAME AND ADDRESS		11. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
12. CONTROLLING OFFICE NAME AND ADDRESS DEPT. OF THE ARMY, CORPS OF ENGINEERS NEW ENGLAND DIVISION, NEDED 24 TRAPELO ROAD, WALTHAM, MA. 02254		13. REPORT DATE April 1979
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. NUMBER OF PAGES 55
16. DISTRIBUTION STATEMENT (of this Report) APPROVAL FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED		17. SECURITY CLASS. (of this report) UNCLASSIFIED
18. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		19. DECLASSIFICATION/DOWNGRADING SCHEDULE
20. SUPPLEMENTARY NOTES Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.		
21. KEY WORDS (Continue on reverse side if necessary and identify by block number) DAMS, INSPECTION, DAM SAFETY, Blackstone River Basin Worcester, Massachusetts		
22. ABSTRACT (Continue on reverse side if necessary and identify by block number) Williams Mill Pond Dam is a 360 foot long, 14 foot high earthfill dam. The dam is in poor condition. If it is retained, certain deficiencies must be corrected to assure its continued performance. For the classification of hazard potential, the dam has been placed in the "low" hazard category.		

WILLIAMS MILL POND DAM

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION
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PROGRAM

PHASE I INSPECTION REPORT

BRIEF ASSESSMENT

Identification No.: MA00121

Name of Dam: Williams Mill Pond Dam

Town: Worcester

County and State: Worcester County, Massachusetts

Stream: Tatnuck Brook - Tributary of the Blackstone
River

Date of Inspection: November 29, 1978

Williams Mill Pond Dam is a 360-foot long, 14-foot high earthfill dam. The original dam at this site, which was constructed around 1888, was partly rebuilt after being washed out in 1923. There is no other information available on the construction of this dam. The stone masonry spillway has a sharp-crested concrete weir and a stepped stone cascade. The 47-foot long spillway crest has been breached in a 20.2-foot section near the right training wall. The crest is at Elevation (El) 505.4 in the breached section and 508.0 in the unbreached section. There is no apparent outlet at this dam.

The dam is in poor condition. If it is to be retained, certain deficiencies must be corrected to assure its continued performance. This conclusion is based on the visual inspection at the site and the lack of available engineering data, or evidence of operational and maintenance procedures. According to the Corps of Engineers guidelines for the classification of hazard potential, the dam has been placed in the "low" hazard category.

The following are visible signs of distress that could indicate a potential hazard at the site: breached section of the spillway; lack of a low level outlet; erosion at several locations along the embankment and down the left bank of the discharge channel;

WILLIAMS MILL POND DAM

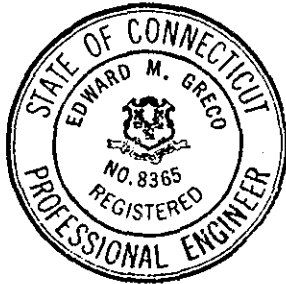
possible seepage through the left embankment; dense growth of trees and brush on both slopes and on the spillway crest; loose and displaced stone blocks on the spillway, the side walls, and the apron of the cascade; erosion and unidentified flow from beneath the concrete retaining wall; and accumulation of branches and debris in the downstream channel.


Hydraulic analyses indicate that the spillway can discharge a flow of 1,900 cfs with the water surface at El 512.6, which is the low point on the crest of the dam. An outflow test flood of 4,170 cfs (one-fourth the estimated probable maximum flood) will overtop the dam by a maximum of 1.8 feet. The spillway can discharge 45 percent of the outflow test flood.

The pond behind the dam is partially silted up and overgrown. Although the dam is in poor condition, it apparently does not represent a hazard to the area. However, should the dam be retained, it is recommended that the Owner employ the services of a qualified consultant to conduct a more detailed hydraulic and hydrologic investigation and design an adequate spillway. In addition, the Owner should selectively clear the brush and trees from the embankment and the spillway; backfill and protect the eroded areas on the crest and slope; repair the side walls and crest of the spillway; control the leak from the left bank of the discharge channel and backfill the eroded area from behind the concrete wall; and clear the branches and debris from the channel at the entrance to Coes Reservoir. The Owner should also implement a systematic program of inspection and maintenance.

The recommendations and remedial measures outlined above and in Section 7 should be implemented by the Owner within a period of one year after receipt of


this Phase I Inspection Report, assuming that the dam will be returned to use. An alternative to these recommendations would be to breach the dam and drain the pond.




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WILLIAMS MILL POND DAM

This Phase I Inspection Report on Williams Mill Pond Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

CHARLES G. TIERSCH, Chairman
Chief, Foundation and Materials
Branch
Engineering Division

FRED J. RAVENS, JR., Member
Chief, Design Branch
Engineering Division

SAUL C. COOPER, Member
Chief, Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

WILLIAMS MILL POND DAM

PREFACE

This report is prepared under guidance contained in Recommended Guidelines for Safety Inspection of Dams, for a Phase I Investigation. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general conditions and the downstream damage potential.

WILLIAMS MILL POND DAM

TABLE OF CONTENTS

	<u>Page</u>
BRIEF ASSESSMENT	
PREFACE	
OVERVIEW PHOTO	iii
LOCATION MAP	iv
REPORT	
SECTION 1 - PROJECT INFORMATION	1
1.1 General	1
1.2 Description of Project	1
1.3 Pertinent Data	5
SECTION 2 - ENGINEERING DATA	8
2.1 General	8
2.2 Construction Records	8
2.3 Operating Records	8
2.4 Evaluation	8
SECTION 3 - VISUAL INSPECTION	10
3.1 Findings	10
3.2 Evaluation	12
SECTION 4 - OPERATING PROCEDURES	13
4.1 Procedures	13
4.2 Maintenance of Dam	13
4.3 Maintenance of Operating Facilities	13
4.4 Description of Any Warning System in Effect	13
4.5 Evaluation	13
SECTION 5 - HYDRAULIC/HYDROLOGIC	14
5.1 Evaluation of Features	14

WILLIAMS MILL POND DAM

TABLE OF CONTENTS (Continued)

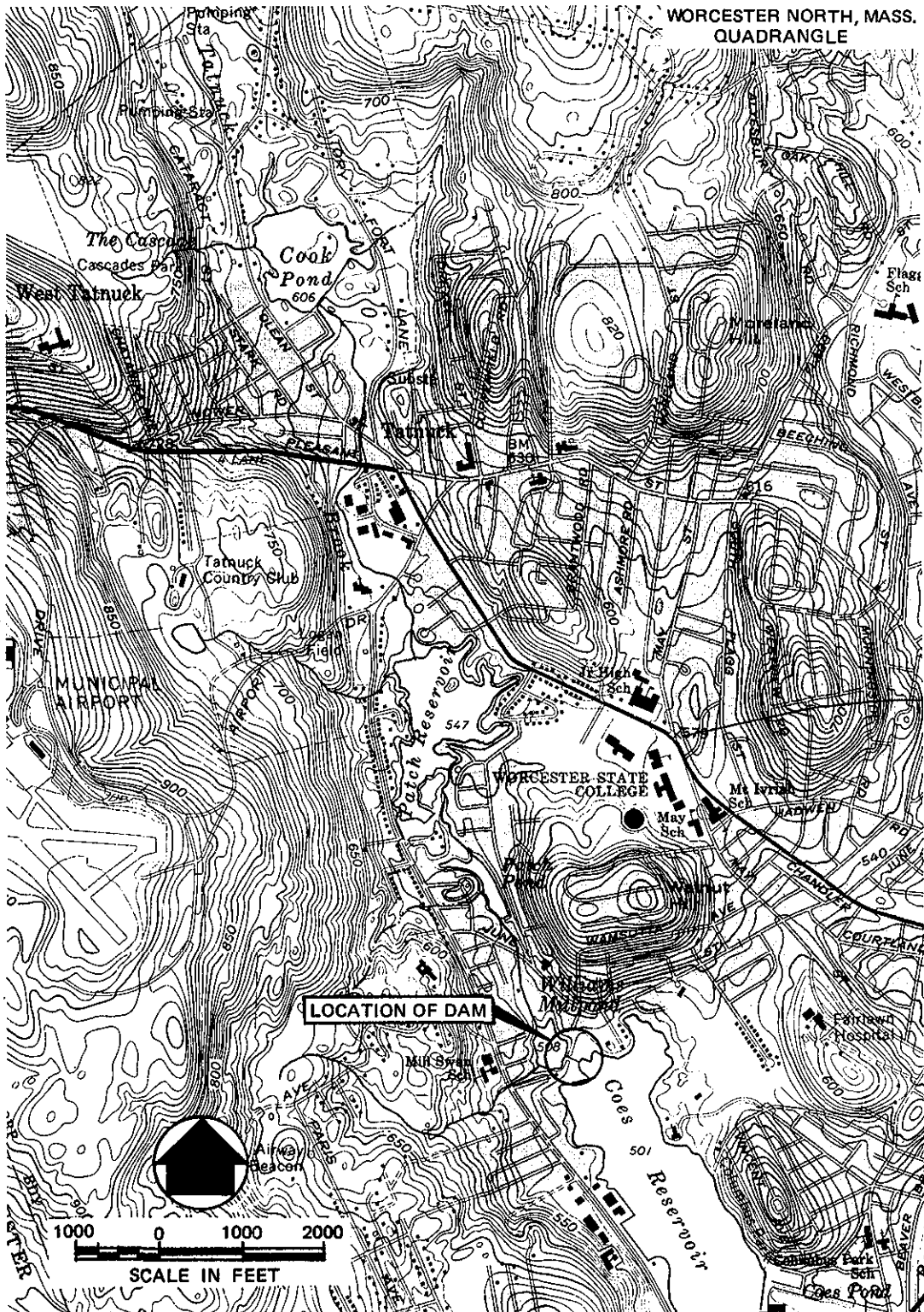
	<u>Page</u>
SECTION 6 - STRUCTURAL STABILITY	17
6.1 Evaluation of Structural Stability	17
SECTION 7 - ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES	18
7.1 Dam Assessment	18
7.2 Recommendations	19
7.3 Remedial Measures	19
7.4 Alternatives	20

APPENDIXES

APPENDIX A - PERIODIC INSPECTION CHECKLIST
APPENDIX B - PLANS OF DAM AND PREVIOUS INSPECTION REPORTS
APPENDIX C - PHOTOGRAPHS
APPENDIX D - HYDROLOGIC AND HYDRAULIC COMPUTATIONS
APPENDIX E - INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

OVERVIEW
WILLIAMS MILL POND DAM
WORCESTER, MASSACHUSETTS





LOCATION MAP - WILLIAMS MILL POND DAM

NATIONAL DAM INSPECTION
PROGRAM

PHASE I INSPECTION REPORT

WILLIAMS MILL POND

SECTION 1

PROJECT INFORMATION

1.1 General

- a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Metcalf & Eddy, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Contract No. DACW 33-79-C-0016, dated November 28, 1978, has been assigned by the Corps of Engineers for this work.
- b. Purpose:
 - (1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.
 - (2) Encourage and assist the States to initiate quickly effective dam safety programs for non-Federal dams.
 - (3) Update, verify and complete the National Inventory of Dams.

1.2 Description of Project

- a. Location. The dam is located on Tatnuck Brook, a tributary of the Blackstone River,

WILLIAMS MILL POND DAM

in the City of Worcester, Worcester County, Massachusetts (see Location Map and Drainage Area Map in Appendix D).

b. Description of Dam and Appurtenances.

Williams Mill Pond Dam is an earthfill dam 360 feet long and a maximum of 14 feet high (see Figures B-1 and B-2). The dam consists of a left and right (north and south) embankment with a central spillway. The crest of the dam, which is uneven and partially eroded, is covered with trees and grass. The maximum width of the crest is 7 feet. The elevation of the crest varies from 511.9 near the left abutment of the spillway to 513.7 on the right embankment. There is no information available on zoning or core of the dam.

The left embankment has upstream and downstream slopes of 2:1 (horizontal to vertical). The right embankment has a slightly steeper upstream slope (about 1.8:1) and a 2:1 downstream slope. Both slopes are heavily overgrown with trees and brush. The area downstream of the right embankment was reportedly filled in to provide parking for construction vehicles. The embankment is less than 4 feet high in this area. There is a lower vacant lot situated downstream of the left embankment. This is the site of the mills that used the water from the dam.

The spillway is in the form of a cascade-type weir comprised of stone masonry. The narrow crest of the weir is constructed of a concrete cap cast over stone blocks and sloped in the downstream direction. The total length of the weir is 47 feet, however, a 20.2-foot section of the crest has been breached by removing part of the concrete cap and one layer of stones from the right end of the weir. The breached section of the weir is at El 505.4, while the maximum elevation of the intact portion is 508.0. At the time of the inspection, water was flowing between the stones on the breached section of the weir. The spillway descends in three stone steps, each about 1.5 feet high, to a stone apron at the toe. On the left side, the apron is formed of placed flat stones, but on the right side, below the breach, the placement of stones is irregular.

WILLIAMS MILL POND DAM

The approach to the spillway is flanked by a stone masonry headwall which extends about 15 feet on either side along the face of the dam. The headwall joins the side walls at the weir. The right side wall extends about 100 feet down the discharge channel from the headwall. It is composed of large stone blocks with unmortared joints. The wall is a maximum of 9 feet high and decreases to 4.5 feet high near the downstream end. Beyond the end of the wall, the spillway discharge flows in a natural stream valley to Coes Reservoir.

The left stone side wall ends at the toe of the spillway and is replaced by a low concrete wall. The wall no longer marks the left side of the channel but extends into the woods below the left embankment for a distance of 105 feet.

The discharge channel is a maximum of 47 feet wide at the upstream end and decreases to about 30 feet wide at the end of the walls. The bottom of the channel is covered with sand and gravel, with some debris. The channel discharges into Coes Reservoir, about 150 feet downstream.

There are no apparent outlet structures at the dam.

- c. Size Classification. Williams Mill Pond Dam is classified in the "small" category since it has a maximum height of 14 feet and a maximum storage capacity of 39 acre-feet.
- d. Hazard Classification. Williams Mill Pond Dam is situated such that complete failure of the dam would cause only minor property damage. The pond itself is located in a heavily populated residential area of Worcester. Two houses adjacent to the abutments could experience minor flooding or undercutting due to failure of the dam. However, there is no development directly downstream of the dam. A filled area below the right embankment is used for parking construction vehicles. Coes Reservoir, which is located about 150 feet below the dam, has a maximum storage capacity of 910 acre-feet, and therefore could easily retain

WILLIAMS MILL POND DAM

the flow resulting from failure of the dam at Williams Mill Pond. For these reasons, the dam has been placed in the "low" hazard category.

- e. Ownership. The dam and pond belong to the estate of Mr. Roland A. O'Keefe. Ms. Elizabeth B. Nolan, 21 Holland Avenue, Riverside, Rhode Island 02915 (telephone 401-433-1274) is the administrator.
- f. Operators. There is no operational equipment at the dam and there are no known operators.
- g. Purpose of Dam. The original dam was built around 1888 to provide water for Thomas William's Woolen Mill. The mill buildings were located below the left embankment of the dam on what is now a vacant lot. There is no evidence of a sluiceway to the mills. The woolen mill closed in 1906 and the dam and buildings were abandoned. The dam and pond have served no purpose other than recreational for many years.
- h. Design and Construction History. There are no records available on the design and construction of this dam. Early inspection reports by the Worcester County Commissioners Office provided only limited background information. A 1920 report stated that the dam had been abandoned and that there was evidence of leakage through the spillway section. Apparently this dam was "washed out" in 1923 (see Appendix B, Previous Inspections, Partial Listing). It is unknown whether the earth embankment or the spillway was breached and to what extent. The 1938 inspection report stated that there was no dam at this location, but the 1944 report describes a "low masonry spillway constructed about 2 feet high in place of one which has not been in for years." The 1955 inspection report stated that the spillway had been partly breached for many years. However, no date is given for the breach.

The 1956 and 1973 inspection reports generally describe the present condition of the dam. The spillway is still partly breached and no apparent repair work was ever done.

WILLIAMS MILL POND DAM

- i. Normal Operating Procedures. There are no operational procedures at the dam. Flow over the spillway is uncontrolled.

1.3 Pertinent Data

- a. Drainage Area. The approximately 6,600 acre (10.3 square mile) drainage area includes the drainage areas of four upstream reservoirs: Holden Reservoirs No. 1 and No. 2, which are City of Worcester water supply reservoirs, and Cook Pond and Patch Reservoir, which are recreational ponds. The northern 75 percent of the drainage area, including the reservoir watersheds and the Cook Pond drainage area, is sparsely developed, heavily wooded, and has moderately steep slopes. The southern portion, including Patch Reservoir, is moderately to densely developed, partially wooded and has gentle to moderately steep slopes.
- b. Discharge. Discharge from Williams Mill Pond is over the ungated spillway and down the stepped-stone cascade. The spillway is 47 feet long, including a 20.2 foot long breached section. The unbreached crest is at El 508.0. Water which flows down the stepped stone cascade and into the stream channel continues into Coes Reservoir 150 feet downstream from the dam.

The combined breached and unbreached sections of the spillway can discharge an estimated 1,900 cfs with the water surface at El 512.6, which is the low point on the crest of the dam. The outflow test flood (one-quarter the PMF) is 4,170 cfs at El 514.4. The spillway has the capacity to discharge 45 percent of the outflow test flood.

The maximum flood level at the dam is unknown. A nearby resident recalls that the dam was overtopped in a 1936 flood.

- c. Elevation (feet above Mean Sea Level (MSL)). A benchmark was established at El 508.0 on the spillway crest. This elevation was taken from a U.S. Geological Survey topographic map.

(1) Top dam: 512.6 to 513.7.

WILLIAMS MILL POND DAM

- (2) Test flood pool: 514.4
- (3) Design surcharge: Unknown
- (4) Full flood control pool: Not Applicable (N/A)
- (5) Recreation pool: 508.0
- (6) Spillway crest (ungated): 508.0
unbreached section; 505.4 breached
section
- (7) Upstream portal invert diversion tunnel:
N/A
- (8) Stream bed at centerline of dam: 500.0
(approximate)
- (9) Maximum tailwater: None

d. Reservoir

- (1) Length of maximum pool: 500 feet
- (2) Length of recreation pool: 500 feet
- (3) Length of flood control pool: N/A

e. Storage (acre-feet)

- (1) Test flood surcharge (net): 34 at El
514.4
- (2) Top of dam: 39
- (3) Flood control pool: N/A
- (4) Recreation pool: 11 (Approximate)
- (5) Spillway crest: 11 (unbreached section)

f. Reservoir Surface (acres)

- *(1) Top dam: 3.8
- *(2) Test flood pool: 3.8

*Based on the assumption that the surface area will not increase significantly with changes in the reservoir elevation from 508.0 to 512.6.

WILLIAMS MILL POND DAM

(3) Flood-control pool: N/A

(4) Recreation pool: 3.8

(5) Spillway crest: 3.8

g. Dam

(1) Type: earthfill

(2) Length: 360 feet

(3) Height: 14 feet

(4) Top width: varies from 3 to 6 feet

(5) Side slopes: upstream - 2:1
downstream - 1.5:1 to 2:1

(6) Zoning: Unknown

(7) Impervious core: Unknown

(8) Cutoff: Unknown

(9) Grout curtain: Unknown

i. Spillway

(1) Type: sharp-crested

(2) Length of weir: 47 feet

(3) Crest elevation: 508.0 MSL (assumed
benchmark, unbreached section) 505.4
breached section

(4) Gates: None

(5) Upstream channel: None

(6) Downstream channel: Maximum 47 feet
wide; narrows to 30 feet wide, 150 feet
long, leads to Coes Reservoir. Floor of
channel is sand and gravel, with rock,
branches and debris obstructing the
flow.

j. Regulating Outlets. There are no regulating
outlets at the dam. Flow over the spillway is
uncontrolled.

WILLIAMS MILL POND DAM

SECTION 2

ENGINEERING DATA

- 2.1 General. There are no plans, specifications, or computations available from the Owner, State, or County relative to the design and construction of this dam. The only data used for this evaluation were the visual observations made during the inspection, a previous inspection report, and conversations with the Owner's representatives and local residents.

We acknowledge the assistance and cooperation of personnel of the Massachusetts Department of Public Works: Messrs. Willis Regan and Raymond Rochford, and of the Massachusetts Department of Environmental Quality Engineering, Division of Waterways: Messrs. John J. Hannon and Joseph Tagallo.

Also, we acknowledge the cooperation and assistance of personnel from the Worcester County Engineer's Office: Messrs. John O'Toole and Joseph Brasauskas.

Ms. Nancy Gaudette, Librarian of the Worcester Collection of the Worcester Public Library, provided information on the early history of the dam and the woolen mills. Additional information was obtained from Mr. Joseph McNamara who lives near the dam.

- 2.2 Construction Records. There are no as-built drawings available for this dam.
- 2.3 Operating Records. No operating records are available, and there is no daily record kept of the elevation of the pool or rainfall at the dam site.
- 2.4 Evaluation
- a. Availability. There is no engineering data available.
 - b. Adequacy. The lack of detailed hydraulic, structural, and construction data did not allow for a definitive review. Therefore,

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 - b. Adequacy. The lack of detailed hydraulic, structural, and construction data did not allow for a definitive review. Therefore,

WILLIAMS MILL POND DAM

the evaluation of the adequacy of this dam is based on visual inspection, past performance history, and engineering judgment.

- c. Validity. It is not possible to judge the validity of the data because there is no engineering or historical information available for this dam.

WILLIAMS MILL POND DAM

SECTION 3
VISUAL INSPECTION

3.1 Findings

- a. General. The Phase I Inspection of the dam at Williams Mill Pond was performed on November 29, 1978. A copy of the inspection checklist is included in Appendix A. Previous inspections of this dam and of the original dam at this site have been made by others since 1925. A partial listing of these inspections is in Appendix B. An inspection was made in 1973 by personnel from the Massachusetts Department of Public Works. A copy of their letter report to the Owner is included in Appendix B.

- b. Dam. Williams Mill Pond Dam consists of an earth embankment with a central masonry spillway. The embankment is in fair to poor condition. Both the upstream and downstream slopes and the crest of the dam are overgrown with thick vegetation, including trees up to 2 feet in diameter. The trees have formed a network of roots that are now exposed on the narrow, uneven crest. There is no riprap visible on the upstream slope of the dam. The areas of local erosion on the upstream slope appear to be due to surface runoff rather than wave action, particularly in the area adjacent to the spillway training walls.

The downstream slope of the embankment also shows some erosion. A large "washout" area is located adjacent to the right training wall of the spillway.

There is no seepage evident at the toe of the slope although the area below the left embankment is apparently supporting marsh-type vegetation. Elsewhere on the left embankment, the slope is covered with construction debris. The area below the right embankment has been filled in to provide parking for construction vehicles belonging to a local resident.

- c. Appurtenant Structures. The concrete and stone masonry spillway is in poor condition.

WILLIAMS MILL POND DAM

The approach to the narrow-crested weir is overgrown with brush and trees up to 10 inches in diameter. The concrete cap to the weir is barely visible through the brush, but that portion that remains appears to be in fair condition. Two iron pins set in the concrete are rusted and bent. The concrete cap is missing in the breached portion of the weir, exposing the underlying blocks of stone.

The training walls on the spillway are in poor condition. The base of the walls on the approach are out of alignment. Patches of loose grout remain between some of the stones but generally the mortar is missing entirely. A few large stones have fallen out of the base of the right wall and form part of the rubble on the breached section of the crest.

The stepped stone cascade is in fair condition. However, the broad flat blocks which form the apron at the toe of the weir are tilted, probably due to erosion of the underlying material.

The masonry on the right side wall of the discharge channel is in fair to poor condition. There are large gaps between the blocks, and the earth above and behind the wall, which supports many trees, has slumped and settled. A few large stone blocks have also fallen from this wall into the discharge channel. The low concrete wall on the left bank of the discharge channel is heavily eroded, particularly near the upstream end. The erosion in this area extends for 7 feet along the back of the wall. The washout appears to have been caused by water discharging from a 14-inch diameter hole in the bank, below the wall. The hole was probed for a distance of 2 feet into the bank, which loosened more sediment until the water ran turbid with orange silt. Flow was estimated at 10 gpm, and the water cleared again after a few minutes. An unsuccessful attempt was made to trace the source of this flow.

- d. Reservoir Area. The pond itself is shallow and heavily overgrown with vegetation, greatly reducing the surface area. The area of

WILLIAMS MILL POND DAM

the pond may increase somewhat during the spring high water period, although at the time of the inspection, water was already overflowing the breached portion of the spillway.

The area around the pond, except at the northern inlet and immediately downstream of the dam, is a heavily developed residential section of Worcester. Future development is unlikely. The area of the pond has moderate slopes ranging from less than 10 percent in the west to 25 percent on the southwest slope of Walnut Hill.

- e. Downstream Channel. Discharge from the spillway enters Tatnuck Brook, which is about 30 feet wide. The bottom of the channel is covered with gravel, bricks and debris. The banks of the stream are low and thickly overgrown with trees and brush.

Water flows downstream at a gradient of about 1 percent to Coes Reservoir, about 150 feet below the Williams Mill Pond Dam. The entrance to Coes Reservoir is choked with fallen tree limbs and debris, and the channel itself is not clearly defined.

- 3.2 Evaluation. The above findings indicate that the dam is in poor condition, and there are several deficiencies which require attention if the dam is to be preserved. It is evident that the dam is not maintained. Recommended measures to improve these conditions are stated in Section 7.3.

SECTION 4

OPERATING PROCEDURES

- 4.1 Procedures. There are no operating procedures at Williams Mill Pond Dam. The mill that formerly used the water no longer exists.
- 4.2 Maintenance of Dam. The heavy accumulation of brush and debris on both the dam and spillway indicates that the dam is not adequately maintained. This condition apparently existed at the time of the 1973 inspection conducted by the Massachusetts Department of Public Works. Also, the eroded areas on the crest and upstream slope of the dam have not been repaired.
- 4.3 Maintenance of Operational Facilities. There are no operating facilities at the dam. Discharge over the spillway is uncontrolled, and the breach in the crest of the spillway weir has never been repaired. There is no other outlet.
- 4.4 Description of Any Warning Systems in Effect. There is no warning system in effect at this site.
- 4.5 Evaluation. There is no regular program of maintenance or warning system in effect at Williams Mill Pond Dam. This would normally be considered an undesirable situation because of the potential danger to lives and property downstream. However, because the dam is classified as "small" and a "low" hazard, and apparently no longer serves any purpose, this condition does not present a particularly serious problem. Were the dam to be repaired and returned to use, a program of inspection and maintenance and a surveillance system should be implemented as recommended in Section 7.3.

WILLIAMS MILL POND DAM

SECTION 5

HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

- a. General. The drainage area of Williams Mill Pond includes four upstream reservoirs, all on Tatnuck Brook: Holden Reservoirs No. 1 and No. 2, which are water supply reservoirs for the City of Worcester, and Cook Pond and Patch Reservoir, which are recreational ponds. The available storage in Williams Mill Pond has been reduced by heavy siltation and growth of vegetation in the pond. The dam is classified in the "small" size category. At the time of the inspection, the water level in the pond was about 7 feet below the top of the earth dam, and water was flowing between the rocks on the breached section of the spillway. Below Williams Mill Pond, Tatnuck Brook flows directly into Coes Reservoir about 150 feet downstream.
- b. Design Data. There are no hydraulic computations available for this dam. The maximum design flow is unknown.
- c. Experience Data. Hydraulic records are not available for this dam. A neighbor recalls that the dam was overtopped during floods in 1936, and after that "the dam was lowered." However, the County list of inspections (see Appendix B) states that the dam was "washed out" in 1923, and "still breached" in 1956. The "breach" may refer to the blocks that were removed from the spillway, but the actual date and reason for the breach is unclear.
- d. Visual Observations. Discharge from Williams Mill Pond is over the ungated spillway, down a stone masonry cascade to the stream channel below. Flood flows could be contained by the high masonry wall on the right side of the channel. However, for the remaining distance to Coes Reservoir, the channel is ill-defined, and flooding of the low area and woods to the left of the channel is likely. The entrance to Coes Reservoir is partially blocked with tree branches.

WILLIAMS MILL POND DAM

There is no other outlet at the dam.

- e.. Test Flood Analysis. Williams Mill Pond receives flow from Patch Reservoir plus 1.4 square miles of tributary drainage area directly below Patch Reservoir. The inflow test flood is based on one-half the test flood outflow from Patch Reservoir (calculated in an earlier report, MA00122, as one-half the PMF) plus 25 percent of the calculated inflow for the incremental drainage area to Williams Mill Pond. The reduction of 25 percent is based on a estimated time lag between peak flows.

The dam has been classified as a small dam of low hazard potential. According to the Corps of Engineers guidelines, the 100-year frequency flood should be used for evaluation of the capacity of the spillway and dam. The 100-year flood for this report has been considered to be equivalent to one-quarter the Probable Maximum Flood (PMF).

The full PMF rate for the drainage area below Patch Reservoir is 2,200 cfs per square mile. This calculation is based on the average drainage area slope of 3.6 percent, the pond-plus-swamp area to drainage area ratio of 2 percent, and the U.S. Army Corps of Engineers' guide curves for Maximum Probable Flood Peak Flow Rates (dated December, 1977). The peak outflow rate for the incremental drainage area is calculated by applying one-quarter the PMF to the 1.4 square miles of tributary drainage. Twenty-five percent of this value was added to the peak outflow from Patch Reservoir, resulting in a total inflow test flood of 4,190 cfs. By adjusting the inflow test flood for surcharge storage, the maximum discharge rate was established as 4,170 cfs or 405 cfs per square mile, with the water surface at El 514.4.

Hydraulic analyses indicate that the combined breached and unbreached sections of the spillway can discharge a maximum 1,900 cfs with the water surface at El 512.6, which is the low point on the crest of the dam. This discharge is 45 percent of the outflow test flood. The maximum head on the crest during the peak

WILLIAMS MILL POND DAM

outflow would be 1.8 feet, with a discharge of 6.2 cfs per foot of width. Depth at the critical flow would be 1.1 feet with a velocity of 5.9 feet per second.

- f. Dam Failure Analysis. The discharge rate due to failure was calculated for the north (left) embankment of the dam. The peak discharge rate would be 2,340 cfs, with a maximum water depth of 4.8 feet. Depending on the location of the failure, the flow would either be contained by the existing channel or possibly overrun the vacant land below the left embankment.

Coes Reservoir is about 150 feet downstream of the dam and there are no structures within the path of a potential flood wave between Williams Mill Pond and the Reservoir. No major damage is likely to occur due to failure of the dam, and the sizeable storage capacity in Coes Reservoir will retain the flow without causing further damage by flooding downstream. For these reasons, the dam has been classified in the "low" hazard category. This classification would probably have to be modified if the vacant land below the dam were to be developed.

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

- a. Visual Observations. The evaluation of the structural stability of Williams Mill Pond Dam is based solely on the visual inspection conducted on November 29, 1978. As discussed in Section 3, Visual Inspection, the dam is in poor condition. Although no seepage was noted, the presence of marsh-type vegetation at the toe of the dam may be an indication of seepage through the foundation. This could eventually affect the stability of the dam.
- b. Design and Construction Data. A note on the Worcester County Inspection Record (Appendix B) stated that a dam at this site was washed out in 1923, and presumably rebuilt after that. However, there are no plans, specifications or computations available on the design, construction, or repair of this dam from the Owner, County, or State.

Information does not appear to exist on the type, shear strength, and permeability of the soil and/or rock materials of the embankment.

- c. Operating Records. There is no evidence that instrumentation of any type was ever installed in Williams Mill Pond Dam. The performance of this dam under prior loading can only be inferred by physical evidence at the site.
- d. Post-Construction Changes. There are no as-built drawings available for the dam. It is assumed that the only post-construction changes involved breaching the crest of the spillway.
- e. Seismic Stability. The dam is located in Seismic Zone No. 2 and in accordance with Phase I "Recommended Guidelines" does not warrant seismic analyses.

WILLIAMS MILL POND DAM

SECTION 7

ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment

- a. Condition. Based upon the visual inspection of the site, and the lack of operational or maintenance information, there are deficiencies which must be corrected to assure the continued performance of this dam. Generally, the dam is considered to be in poor condition. Several signs of distress were observed at the site: loose stone blocks in the breached section of the spillway; lack of a low-level outlet from the pond; erosion at several locations along the embankment; possible seepage through the toe of the left embankment; dense growth of trees and brush on both slopes and the crest of the embankment, and on the approach to the spillway; deterioration and localized collapse of the spillway stone side walls; settlement and displacement of the stone blocks forming the apron of the spillway cascade; erosion of the left bank of the discharge channel and deterioration of the concrete retaining wall; unidentified flow beneath the retaining wall; and accumulation of branches and debris in the downstream channel.

Hydraulic analyses indicate that the spillway can discharge a flow of 1,900 cfs with the water surface at El 512.6 which is the low point on the crest of the dam. An outflow test flood of 4,170 cfs (one-fourth the probable maximum flood) will overtop the dam by 1.8 feet.

- b. Adequacy. The lack of detailed design and construction data did not allow for a definitive review. Therefore, the evaluation of the adequacy of this dam is based primarily on the visual inspection, past performance, and engineering judgment.
- c. Urgency. The recommendations and remedial measures outlined below should be implemented

WILLIAMS MILL POND DAM

by the Owner within one year after receipt of this Phase I Inspection Report assuming that the dam will be retained.

- d. Need for Additional Investigation. Additional investigations to further assess the adequacy of the dam are outlined below in Section 7.2 Recommendations.

7.2 Recommendations. As a result of the visual inspection and a review of limited available data, further investigations to assess the adequacy of the dam are not considered necessary unless the dam is to be retained. Rehabilitation of the dam would require that the Owner hire a qualified consultant to conduct a more detailed hydraulic and hydrologic investigation and design an adequate spillway.

The necessary repair and maintenance procedures are outlined in Section 7.3.

7.3 Remedial Measures

- a. Operating and Maintenance Procedures. The dam and spillway are not adequately maintained. It is recommended that the Owner accomplish the following:
 - (1) construct a low-level outlet
 - (2) clear the brush, trees and stumps from the embankment
 - (3) backfill and protect the eroded areas on the crest and slopes of the embankment
 - (4) place riprap on the upstream face of the dam
 - (5) investigate the source and control the leak from the left bank of the discharge channel
 - (6) backfill the eroded areas behind the concrete side wall
 - (7) clear branches and debris from the channel at the entrance to Coes Reservoir

WILLIAMS MILL POND DAM

- (8) implement a systematic program of maintenance inspections. As a minimum, the inspection program should consist of a monthly inspection of the dam and appurtenances, supplemented by additional inspections during and after severe storms. All repairs and maintenance should be undertaken in accordance with all applicable State regulations.
- (9) periodic technical inspections of this dam should be continued on an annual basis
- (10) institute a definite plan for surveillance and a warning system during periods of unusually heavy rains and/or runoff.

7.4 Alternatives. If the dam is not to be retained, the alternative is to breach it and drain the pond.

APPENDIX A
PERIODIC INSPECTION
CHECKLIST

WILLIAMS MILL POND DAM

PERIODIC INSPECTION

PARTY ORGANIZATION

PROJECT Williams Mill Pond

DATE 11/29/78

TIME 8:30 am

WEATHER sunny, 20's

W.S. ELEV. 305.8 U.S. 500.7 D.N.S.

Assumed benchmark E1 508.0
at crest of unbreached section of
spillway.

ARTY:

- | | |
|----------------------|-------------------------|
| 1. <u>S. Pierce</u> | 6. <u>Ed Greco</u> |
| 2. <u>D. Cole</u> | 7. <u>Lyle Branagan</u> |
| 3. <u>B. Checchi</u> | 8. _____ |
| 4. _____ | 9. _____ |
| 5. _____ | 10. _____ |

PROJECT FEATURE	INSPECTED BY	REMARKS
<u>Dam</u>	<u>E. Greco / S. Pierce</u>	
<u>Spillway</u>	<u>L. Branagan</u>	

PERIODIC INSPECTION CHECK LIST

PROJECT Williams Mill Pond DATE 11/29/78
 PROJECT FEATURE Dam NAME E. Greco
 DISCIPLINE Geotechnical NAME S. Pierce

Note: d/s = downstream; u/s = upstream

AREA EVALUATED	CONDITIONS
<u>DAM EMBANKMENT</u>	Earth embankment to left of spillway
Crest Elevation	512.6 to 513.7
Current Pool Elevation	505.8
Maximum Impoundment to Date	unknown
Surface Cracks	not applicable
Pavement Condition	crest uneven, many depressions. trees up to 2-ft diameter on both slopes
Movement or Settlement of Crest	none visible
Lateral Movement	not apparent
Vertical Alignment	n/a
Horizontal Alignment	fairly straight
Condition at Abutment and at Concrete Structures	natural ground at left abutment. Spillway training wall at right abutment
Indications of Movement of Structural Items on Slopes	not visible
Trespassing on Slopes	Construction debris dumped on d/s slope
Sloughing or Erosion of Slopes or Abutments	u/s slope: eroded areas adjacent to left wall of spillway, and about 1/2-way between spillway and left abutment
Rock Slope Protection - Riprap Failures	no riprap visible - overgrown by brush and covered with trees
Unusual Movement or Cracking at or near Toes	none visible
Unusual Embankment or Downstream Seepage	no seepage evident (thin, icy snow cover) marsh type grass growing on d/s toe
Piping or Boils	none visible
Foundation Drainage Features	none
Toe Drains	none
Instrumentation System	none

PERIODIC INSPECTION CHECK LIST

PROJECT Williams Mill Pond

DATE 11/29/78

PROJECT FEATURE Dike

NAME E. Greco

DISCIPLINE Geotechnical

NAME S. Pierce

AREA EVALUATED	CONDITION
<u>DAM EMBANKMENT</u>	Earth embankment to right of spillway
Crest Elevation	
Current Pool Elevation	
Maximum Impoundment to Date	
Surface Cracks	
Pavement Condition	grass and brush, same as dam
Movement or Settlement of Crest	none visible
Lateral Movement	-
Vertical Alignment	-
Horizontal Alignment	fairly straight
Condition at Abutment and at Concrete Structures	right abutment - natural ground, house left abutment - training wall of spillway
Indications of Movement of Structural Items on Slopes	none visible
Trespassing on Slopes	foot path
Sloughing or Erosion of Slopes or Abutments	u/s - adjacent to right spillway abutment d/s - low "washout" area adjacent to spillway training wall
Rock Slope Protection - Riprap Failures	none visible. Stone wall built along pond u/s of right abutment
Unusual Movement or Cracking at or near Toes	none visible
Unusual Embankment or Downstream Seepage	none visible
Piping or Boils	none
Foundation Drainage Features	none
Toe Drains	none
Instrumentation System	none

PERIODIC INSPECTION CHECK LIST

PROJECT Williams Mill Pond DATE 11/29/78
PROJECT FEATURE Outlet NAME E. Greco
DISCIPLINE Geotechnical NAME S. Pierce

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE</u>	No outlet works
a. Approach Channel	
Slope Conditions	
Bottom Conditions	
Rock Slides or Falls	
Log Boom	
Debris	
Condition of Concrete Lining	
Drains or Weep Holes	
b. Intake Structure	
Condition of Concrete	
Stop Logs and Slots	

PERIODIC INSPECTION CHECK LIST

PROJECT Williams Mill Pond DATE 11/29/78
 PROJECT FEATURE Spillway NAME L. Branagan
 DISCIPLINE Hydraulics NAME _____

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS</u>	
.. Approach Channel	submerged, overgrown
General Condition	very poor
Loose Rock Overhanging Channel	wingwalls misaligned at base mortar missing; a few rock blocks have fallen onto channel and weir
Trees Overhanging Channel	brush, and trees up to 10" diameter growing in channel
Floor of Approach Channel	
.. Weir and Training Walls	see page A-6
General Condition of Concrete	concrete cap apparently cast over stone blocks of weir, later breached in 20-foot section on right end of weir
Rust or Staining	n/a
Spalling	n/a
Any Visible Reinforcing	n/a
Any Seepage or Efflorescence	seepage (~10gpm) flowing from 14" dia. hole* in bank below concrete retaining wall in channel
Drain Holes	none
.. Discharge Channel	dry stone masonry wall continues on right side; low concrete wall on left bank eroded**
General Condition	fair to poor
Loose Rock Overhanging Channel	none
Trees Overhanging Channel	few trees, some brush from side walls
Floor of Channel	sand, gravel, bricks, and debris
Other Obstructions	channel width reduced by debris and trees before it enters Coes Reservoir

* probed hole for 2 feet, clear water turned orange and very silty, ran clear again after ~ 2 minutes

* Erosion behind this wall extends for 7 feet along the wall

PERIODIC INSPECTION CHECK LIST

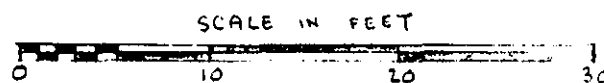
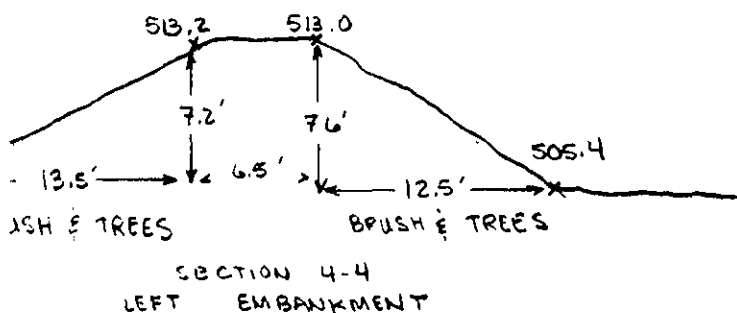
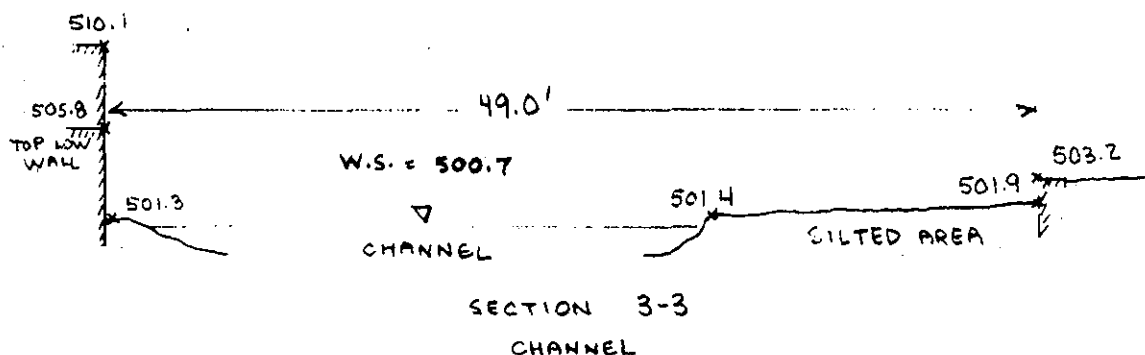
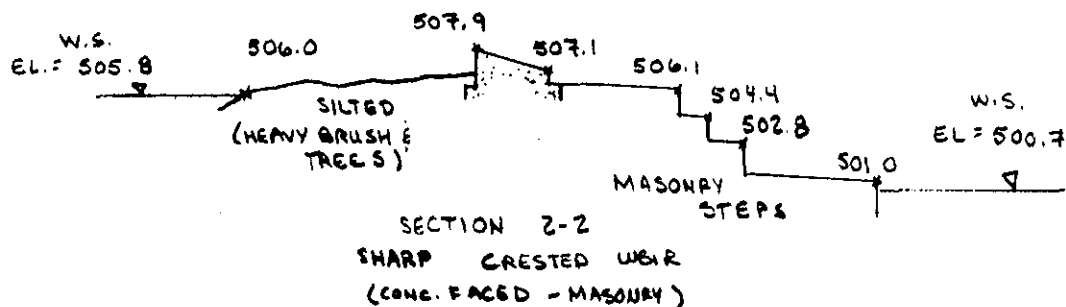
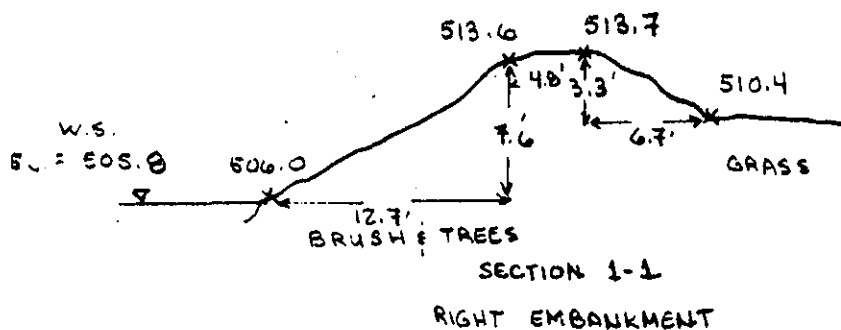
PROJECT Williams Mill Pond DATE 11/29/78
 PROJECT FEATURE Spillway NAME L. Branagan
 DISCIPLINE Hydraulic NAME _____

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS b. Weir and Training Walls	Continued from page A-5 - Weir is formed by concrete cap cast over stone blocks - Cap is tilted downstream, changes to rocks on d/s side of crest - Two iron pins with nuts exposed in concrete - right end of crest apparently breached: concrete removed, exposing blocks underneath - Weir leads to 4-step stone cascade; - large rock slabs at toe of cascade, - rock slabs tilted, misaligned, also missing from right side Training walls: stone masonry; patches of loose grout remain in places, the rest is without any mortar

APPENDIX B
PLANS OF DAM AND PREVIOUS
INSPECTION REPORTS

	<u>Page</u>
Figure B-1, Plan of Dam	B-1
Figure B-2, Sections through Dam	B-2
Previous Inspections (Partial Listing)	B-3
Letter to Owner from Massachusetts Department of Public Works,	B-4

WILLIAMS MILL POND DAM



METCALF & EDDY, INC. ENGINEERS BOSTON, MA.	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS BALTIMORE, MD.
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	
WILLIAMS MILL POND DAM	
FIGURE B-2 SECTIONS THROUGH DAM	
TRIBUTARY BLACKSTONE RIVER	MASSACHUSETTS
SCALE: 1" = 10'	DATE: JANUARY, 1979

METCALF & EDDY, INC.

B-3

TOWN OR CITY <i>Worcester</i> DECREE NO.		PLAN NO.	DAM NO. <i>64-09</i>
LOCATION <i>Mill pond south of June St.</i>		C.C. DOCKET NO. <i>348</i>	
DESCRIPTION OF DAM		DESCRIPTION OF RESERVOIR & WATERSHED	
Type	Name of Main Stream <i>Tatnuck brook</i>		
Length	" " any other Streams		
Height	Length of Watershed		
Thickness top	Width " "		
" bottom	Is Watershed Cultivated		
Downstream Slope	Percent in Forests		
Upstream "	Steepness of Slope	<i>trace</i>	
Length of Spillway	Kind of Soil		
Size of Gates	No. of Acres in Watershed		
Location of Gates	" " " " Reservoir <i>6</i>		
Flashboards used	Length of Reservoir		
Width Flashboards or Gates	Width " "		
Dam designed by	Max Flow Cu. Ft. per Sec.		
" constructed by	Head or Flashboards-Low Water		
Year constructed	" " " " -High "		
GENERAL REMARKS		GENERAL REMARKS	
<i>L.H. Johnson - owner - Washed out. 1923</i> <i>Owned 1937 by Grace M. Foster June St.</i> <i>Inspected: Aug. 15, 1925 - L.O. Marden.</i> <i>Inspected: Nov. 17, 1938 - L. H. Spofford</i> <i>" Dec. 15, 1944 - L.O.M. - W.O.L.</i>		<i>Owned by Arthur Gasparian</i> <i>June St. Wobc. died 1961</i> <i>Still breached 1956</i> <i>N.R.F.</i> <i>OWNER - ROLAND A. O'KEEFE</i>	

2-Library Bureau 10-92200

PREVIOUS INSPECTIONS (PARTIAL LISTING)

COPY OF INSPECTION CARD ON FILE AT THE MASSACHUSETTS
DEPARTMENT OF PUBLIC WORKS, DISTRICT OFFICE, WORCESTER.



The Commonwealth of Massachusetts

Executive Office of Transportation and Construction

Department of Public Works

100 Nashua Street, Boston 02114

April 30, 1973

Mr. Poland O'Keefe
16 Southern Drive
Worcester, Massachusetts

RE: Dam #3-14-348-9
Worcester
Williams Mill Pond Dam

Dear Mr. O'Keefe:

Reference is made to your letter, dated April 20, 1973, wherein you mention misplacing my letter, dated March 29, 1973, a copy of which is enclosed.

In response to your problem of removal and control of aquatic weed growth by chemical treatment I regret to inform you that this Division cannot be of assistance, or provide you with a cost estimate for such a project. You may, however, refer this matter to Mr. Mario Boschetti of the Massachusetts Department of Public Health, Division of Environmental Health, at 600 Washington Street, Boston, Massachusetts (telephone 727-2692). You may also wish to mention the problem of the snapping turtle to him.

The conditions requiring your attention as mentioned in my letter of March 29, 1973, can wait until you return from Vermont in the Fall.

Your request of our permission to sell your property is not necessary, as it is your decision to make.

If we may be of some other assistance please do not hesitate to contact us.

Very truly yours,

FRED. C. SCHWEIM, P.E.
Deputy Chief Engineer

LPA/afs

cc: G. E. Lybrand DHE#3
A. Troiano, Dist#3

Enclosure:

B-4

APPENDIX C
PHOTOGRAPHS

WILLIAMS MILL POND DAM



NO. 1 DOWNSTREAM VIEW OF LEFT EMBANKMENT



NO. 2 CREST OF RIGHT EMBANKMENT

WILLIAMS MILL POND DAM



NO. 3 SPILLWAY AND LEFT EMBANKMENT



NO. 4 SPILLWAY CASCADE AND LEFT TRAINING WALL

WILLIAMS MILL POND DAM



**NO. 5 EROSION OF CONCRETE WALL ON
LEFT BANK OF DISCHARGE CHANNEL**



**NO. 6 BREACHED SECTION OF SPILLWAY
AND RIGHT TRAINING WALL**

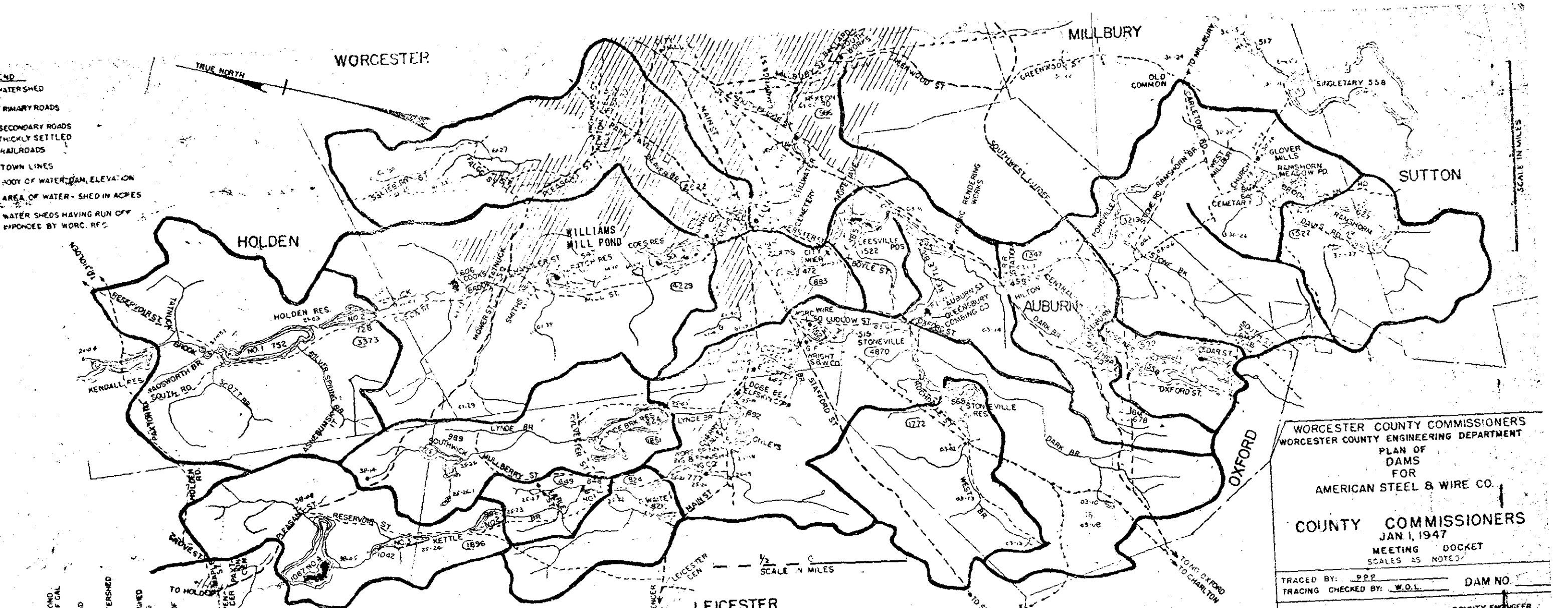
WILLIAMS MILL POND DAM

APPENDIX D
HYDROLOGIC AND HYDRAULIC
COMPUTATIONS

	<u>Page</u>
Figure D-1, Watershed Plan	D-1
Figure D-2, Watershed of Southworks Pond	D-2
Computations	D-3



FIG. D-1 DRAINAGE AREA MAP – WILLIAMS MILL POND DAM



WORCESTER COUNTY COMMISSIONERS
WORCESTER COUNTY ENGINEERING DEPARTMENT
PLAN OF
DAMS
FOR
AMERICAN STEEL & WIRE CO.

COUNTY COMMISSIONERS
JAN. 1, 1947
MEETING DOCKET
SCALES AS NOTED

TRACED BY: PPP DAM NO. 1
TRACING CHECKED BY: W.O.L.
COUNTY ENGINEER

NO.	CAPACITY OF POND IN MILLIONS OF GAL.	AREA OF POND IN ACRES	INDIVIDUAL WATERSHED IN ACRES	TOTAL WATERSHED IN ACRES	ELEV. OF TOP OF DAM SPILLWAY	ELEV. OF TOP OF FLASHBOAT TO SPILLWAY	ELEV. OF TOP OF FLASHBOAT TO SPILLWAY	YEAR BUILT	TYPE OF DAM	HIGH WATER MARK & WATER RIGHTS	YEAR ESTABLISHED	FLOW CONTROLLED BY	MISC. INFORMATION
1	2.3	5.3		443.40	1814	1899			EARTH MASONRY TOWER CORE PLAN 8177, 1899	ELEV. 443.47 COPPER BOLT TOP OF STONE BOUND 1.5 SOUTH OF AND 153' W. FROM S.E. COR. OF MILL POND PLAN 127 WASHBURN MOEN MFG. CO. VERSUS CROMPTON CARPET CO. DEFENDANT	1873 BY SUPERIOR COURT DECREE VOL. 22	AMERICAN STEEL & WIRE CO.	OLDEST WATER PRIVILEGE IN SYSTEM, WORCESTER COUNTY ELEC. LIGHT CO. USES 2 MIL. GAL. 24 HRS. (1921) FOR CONDENSING. POND KEPT FULL
2	160	62	883	4563					GATE IS SCREW STEM 24" PIPE EARTH WITH CONCRETE CORE WALL PLAN FOR CORE WALL 8642 CONCRETE STILLWALL PLAN 13530-31 10591 REPAIRS	ELEV. 473.51 TWO FEET BELOW BOLT IN EAST CONCRETE WALL OF SPILLWAY WORCESTER ELEC. LIGHT CO. PLAN 13530-31 WATER RIGHTS PURCHASED 1917 FROM TOWN OF HEIRS. B. 23	JAN. 30, 1914 BY H.A. PRATT PRIV. ENG.	AMERICAN STEEL & WIRE CO.	NECESSARY TO KEEP POND FULL FOR SUCTION OF THEIR PUMPS
3	40	26.4	1347	5-22	96.56	9838		1939	CONCRETE GRAVITY SECTION COVERED WITH EARTH GATE SCREW STEM 30" X 30" BOX OUTLET	ELEV. 102.05 BRASS PLUG IN LEDGE EAST SIDE OF POND SOUTH OF SPILLWAY CREST PLANS 14628-SEE PLAN 8044A FOR PARCELS PURCHASE - ALSO 8-71-8777	OCT. 21, 1924 BY COUNTY COMM.	AMERICAN STEEL & WIRE CO.	DURING SUMMER MONTHS RESERVOIR LOSES 2' OF WATER WITHOUT DRAW DOWN
4	255	158	699	699	11079	11217		1921	STONE MASONRY	ELEV. 24.29' ROM PIN IN LEDGE ON WESTERLY SHORE ELEV. OF N.W. COR. OF N. & BRIDGE WING WALL - 32.00	872 REG. OF DEEDS BK. 875 P. 32-149 PURCHASED BY A. CURTIS AS TRUSTEE FOR RAMSHORN POND CO. PREVIOUS TO RAISING DAM	AMERICAN STEEL & WIRE CO.	MIN. FLOW REQ. BY SMALL MILLS WHEN IN OPERATION IS 6" THRU 36" WIDE
5	720	148	1527	1527	22.0	24.0		1872-3	PREVIOUSLY ADDED GATE SCREW STEM 24" & OUTLET PIPE (POSSIBLY) 30" EARTH PUDDLED TO EITHER SIDE CHESTNUT CUTOFF WALL ALONG DAM & 13.31 PLAN 13515 A.B.B.	PROPERTY MAP 8023		AMERICAN STEEL & WIRE CO.	NEVER HAS EXCEEDED 10' OVER SPILLWAY USED FOR IMPROVING DURING RAISING & WATER TO ENSURE CLOSING DAMS
6	22	38	580	12.27				1916	GATE EARTH WITH CONCRETE CORE WALL, CONCRETE SPILLWAY PLAN 7	PROPERTY MAP 8769 (1904)		AMERICAN STEEL & WIRE CO.	WATER OTHER USE IS FOR CLEANING
7	35	30	605	2439					RACK PINION 2 CONCRETE	PROPERTY MAP 8769 (1904)		AMERICAN STEEL & WIRE CO.	THE AGREEMENT IS THAT GUENSBURY COMBING CO. CAN DRAW SUFFICIENT WATER TO RUN PLANT WE CAN OBTAIN WATER BY CONSULTING N.E. POWER CO.
8	45	4870	7466									AMERICAN STEEL & WIRE CO.	DAM WASHED OUT
9	195	68	1772	1772					GATE EARTH & STONE WALL 30" & OUTLET	FROM M. BORTZ 1917 BK. 2123, P. 290	AP. 29, 1909 BK. 1904, P. 68 THIS IS (TAYLOR DEED)	AMERICAN STEEL & WIRE CO.	15,700,000 GAL. PER DAY REQ. FOR SOUTH WORKS & WIRE MILLS AS MEASURED IN 1942 PREPARATORY TO INTER CHANGES
10	15	15	83	782					FLOOD GATE RACK & PINION INTAKE GATE SCREW STEM INSTALLED IN 1943 MASONRY PLAN 3955 INTAKE 14.652 A.M. REPAIRS TWO POND 3265 (1926), 2192 1926	ELEV. 443.47 SAME AS CENTRAL WORKS! ESTABLISHED IN EXCHANGE OF TITLES WHEN HOLY 32.00 AM S.B.W. CO. CITY OF WORCESTER AND 26.6' A.M. TAYLOR PROP. PLAN 8769		AMERICAN STEEL & WIRE CO.	
PLANS FOR MOSS RES. DAM CONCRETE ORIGINAL DAM 8510 TO 12, PRES. COAST 10384, 10382-3, 6507 & 51400, 514628 PROPERTY, 1877, 8044A & LOTS PURCHASED IN CEDAR SWAMP 8771													
INTERFERED BY CITY STREETS AND STORM SEWERS PLANS FOR MOSS RES. DAM CONCRETE ORIGINAL DAM 8510 TO 12, PRES. COAST 10384, 10382-3, 6507 & 51400, 514628 PROPERTY, 1877, 8044A & LOTS PURCHASED IN CEDAR SWAMP 8771													
REVISION SHOWN ON THIS PLAN WAS DRAWN EXISTING PLANS, & FROM FILES OF SUPT. OF ENG. & MAINT. ONLY THE 2.6 GOODRICH REPORT NOV. 14, 1921 AND "MOSS RESERVOIR" DATA CONCERNING ORIGINAL OWNERS OF CEDAR SWAMP													

AMERICAN STEEL & WIRE CO.
SUBSIDIARY OF
UNITED STATES STEEL CORPORATION
ENGINEERING DEPARTMENT
WORCESTER MASS
U.S.
DRAWN BY JAN. 1, 1947, BROUGHT
SCALE 1" = 1/2 MILE
FIGURE D-2 17720
WATER SHED OF
SOUTHWORKS POND

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I Test Flood, Storage & Storage Function

Total Drainage Area - 10.3 mi^2 , Pond Surface Area - 0.006 mi^2

Patch Res, approx. 3000 ft. upstream has an 8.9 mi^2 drainage area and a $\frac{1}{2}$ PMF outflow of 7950 c.f.s. in a prior Phase I analysis.

The incremental drainage area to Williams Millpond of 1.4 sq miles has 2% of the area in ponds & swamps and a 3.6% slope. The incremental area has been taken as similar to "Rolling" with a P.F.R. of 2200 c.f.s. per sq. mile

Peak flow from Patch Res. (and upstream) should be later in time than that from the incremental drainage area. A 0.5 hour time difference would allow the peak Patch outflow to match with 20% of the peak from the incremental area. [Ref.: S.C.S. - Tabular Method], For this analysis use 25% of the peak flow from the incremental area.

Williams Millpond dam is "SMALL". Coes Reservoir is immediately downstream and the hazard class is "LOW". The Test Flood is 50 to 100 yr frequency flood. Assume that $\frac{1}{4}$ PMF \approx 100 yr. freq. flood, with $\frac{19}{4} = 4.75$ in. rainfall

$$\begin{aligned} \text{Peak Patch outflow} &= \frac{1}{2} 7950 \approx 4000 \text{ c.f.s.} \\ \text{Adj. Incremental Peak} &= \frac{1}{4} (1.4) 2200 (0.25) = 190 \\ \text{Inflow Test Flood} &= 4190 \text{ c.f.s.} \end{aligned}$$

Storage on the 0.006 mi^2 pond is 3.8 acre ft / ft rise

Storage Function

$$* F_{TF} = 4190 - 882(12) \frac{0.006}{10.3} D = 4190 - 6D$$

where D = Storage depth in ft. above the spillway crest @ el. 506 (\pm)

$$* \text{Based on } Q_{P_2} = Q_{P_1} \left(1 - \frac{\text{Storage in terms of inches of rainfall on D.A.}}{\text{Inches of Rain on D.A. for Test Flood}} \right)$$

For Spillway Test use: $F_{\frac{1}{2} \text{ PMF}} = 8380 - 6D$

II Discharge Relations

Note: The spillway is broken with the north end higher than the south - & with differing discharge characters

A - Spillway - North End

Length 26.8', Crest - Sharp, Elev. Crest 507.9 ±

Use Williams & Hazen "Hydr. Tables" with $f_p = 6'$ & extrapolation

Pond Elev.	509	510	512	513	514	515	516	517
H_{SN}	1.1	2.1	4.1	5.1	6.1	7.1	8.1	9.1
Q	3.9	10.4	29.6	41.9	54.7	68.6	82.5	96.4
Q_{SN}	100	280	790	1120	1470	1840	2210	2580

B - Spillway - South End.

Length 20.2', Crest - Broad; Elev. Crest 505.4

Use $q = 2.55 (H_{ss})^{3/2}$ [Ref. V.T. Chow "Open Chan. Hydr." pg 52-53]

Pond Elev.	509	510	512	513	514	515	516	517
H_{ss}	3.6	4.6	6.6	7.6	8.6	9.6	10.6	11.6
q	17.4	25.2	43.2	53.4	64.3	74.4	88.0	100.7
Q_{ss}	350	510	870	1080	1300	1500	1780	2040

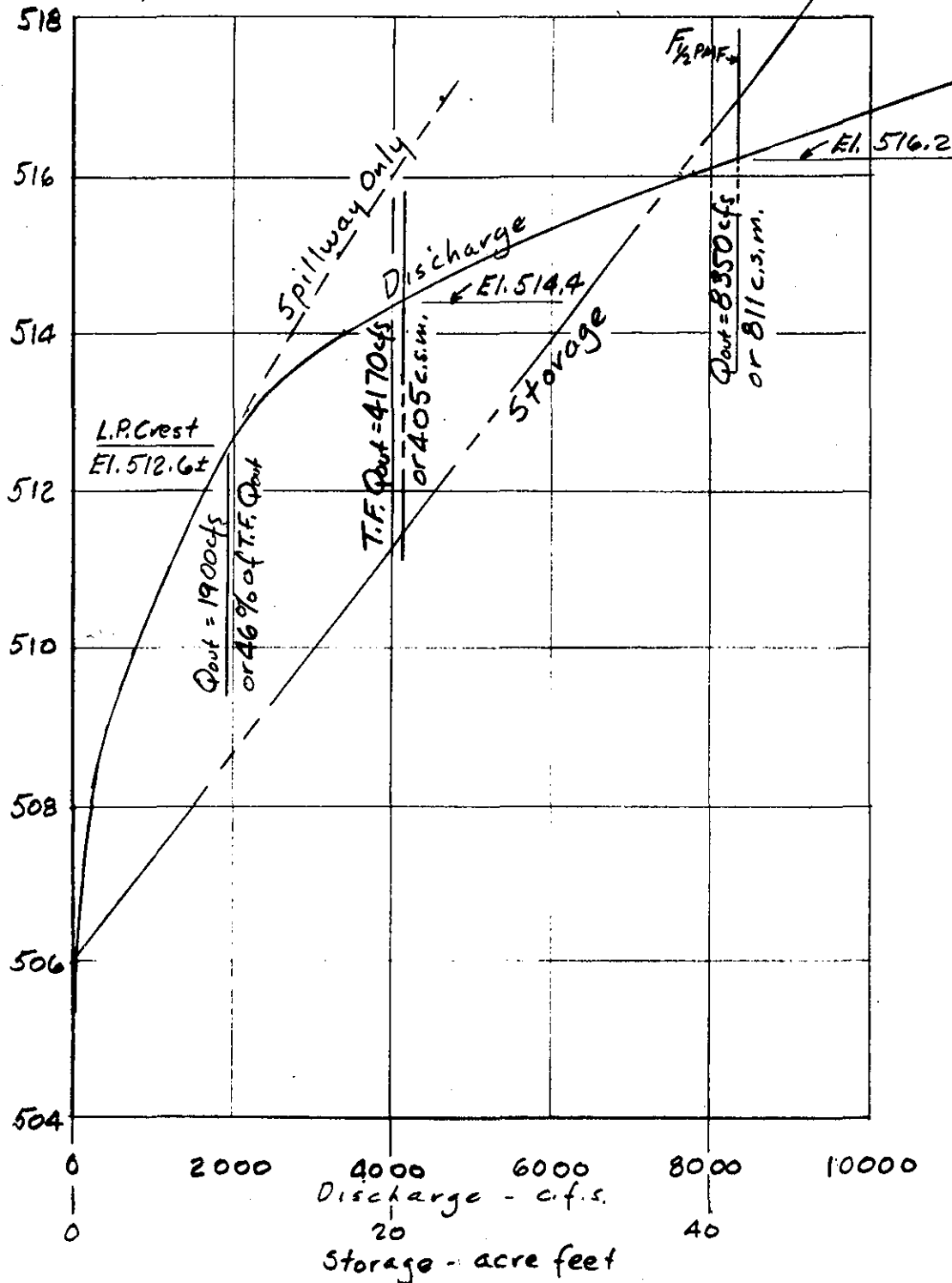
C - Crest Flow

Length - 60' @ el. 512.6 ±; 190' @ el. 513.2, 60' @ el. 513.7

Use $q = 2.55 (H_c)^{1.5}$ - same as Item B above.

Pond Elev.	513	514	515	516	517
Q_{c1}	40	250	570	960	1410
Q_{c2}	—	350	1170	2270	3590
Q_{c3}	—	30	230	530	920
ΣQ_c	40	630	1970	3760	5920

III Discharge, Storage & Storage Function vs Pond Elev.



Project: Nat. Review of Non Fed. Dams Acct. No. 6191 Page 4 of 5
 Subject: Worcester County Area Comptd. By: LEB Date: 12/18/78
 Detail: WILLIAMS MILLPOND Ch'd. By: see OK Date: 20 DEC 1978

IV Crest Flow (Test Flood)

$$\text{Max head on crest} = 514.4 - 512.6 = 1.8 \text{ ft.}$$

$$q = 2.55 (1.8)^{1.5} = 6.2 \text{ cfs/ft of width}$$

Critical Flow Conditions

$$y_c = \left(\frac{q^2}{g} \right)^{1/3} = 1.06 \text{ ft.}, V_c = 5.9 \text{ f.p.s.}$$

RELIANT & LOWE, ENGINEERS

⑦ Failure of Dam

Peak Failure Flow:

Pond Elevation - 512.6 (L.P. Dam Crest.)

Toe Elevation - 505.4

$$Y_0 = 7.2$$

Dam Length Subject to Breaching = 180 (No end)

$$W_0 = 40\%(180) = 72$$

$$Q_R = 1.68 W_0 (Y_0)^{1.5} = 1.68 (72) (7.2)^{1.5} = \underline{2340 \text{ cfs.}}$$

Storage Volume Released:

Storage Above Spillway $6.6 \times 3.8 = 25$ acre feet

Storage Below Spillway $\pm 3' \times 3.8 = 11$ " "

S = Total Storage = $\underline{36}$ " "

Channel Hydraulics:

Coe's Reservoir is $\pm 200'$ dustr. of Williams Millpond. No structures occur between the ponds on the line of the failure flow. Failure discharge would have a max. depth of $\frac{2}{3}(7.2') = 4.8$ feet. Depending on the location of the failure, breach flow would spread over the wasteland between the ponds or run to the existing channel.

Time to Drain:

$$\frac{43560 (36)}{3600 (\frac{1}{2}) (2340)} = 0.37 \text{ Hours, or 22 Minutes}$$

APPENDIX E

INFORMATION AS CONTAINED IN THE
NATIONAL INVENTORY OF DAMS

WILLIAMS MILL POND DAM